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Three Pine Release Experiments in Northern Minnesota

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ABSTRACT

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Three pine release experiments were begun in northern Minnesota in the 1930's. Two experiments compared the response of pines to full, moderate, and no release from competing hardwoods; the third compared only moderate and no release. Eighteen to twenty-five years later the pines responded most favorably on the full release treatments, intermediate on moderate release, and least favorably with no release. Financial aspects are briefly discussed and indicate that release, as done in these experiments, is one of the better investments to be made in forestry.

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Three Pine Release Experiments In Northern Minnesota

by

Robert E. Buckman and Allen L. Lundgren[1]

Release of young natural stands and plantations from competing trees of lesser quality or value has long been regarded as a favorable forestry practice in the Lake States. Many thousands of acres of pines were released from competing hardwoods during the Civilian Conservation Corps program of the 1930's, and this practice has been continued by public and private forestry agencies alike in the years since.

In the 1930's three experiments were begun in young pine stands in Minnesota to study the effects of release. These three release studies have now been followed for from 18 to 25 years. Although the studies differ in many important respects, the results all show an appreciable response to the release — a response that by financial standards makes release a worthwhile investment.

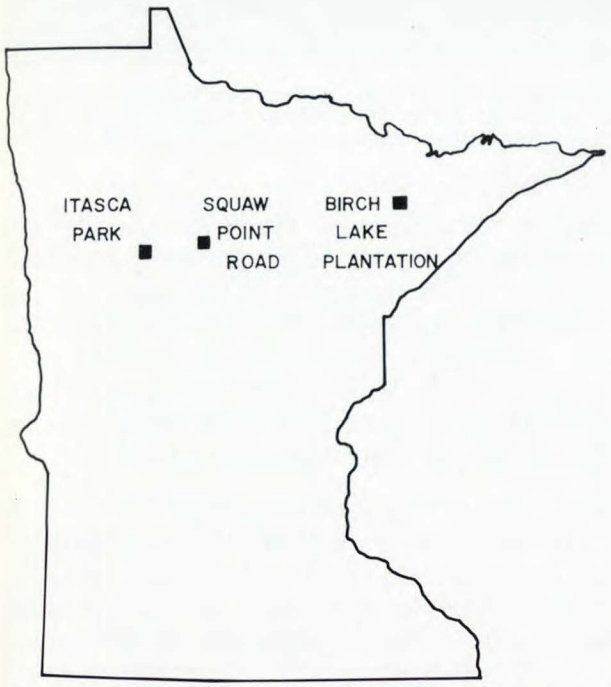

FIGURE 1. — Location of three pine release studies in northern Minnesota.

This paper examines mainly the silvicultural results of the three experiments. A short section of the paper highlights the economic consequences of release. A more detailed discussion of the methods and of the results of the economic analysis will appear in a separate paper now being prepared by the junior author.

The Study Plots

The three studies were installed in young pine that contained mixtures of aspen (*Populus tremuloides* Michx.) and paper birch (*Betula papyrifera* Marsh.). Two of the experiments, the Squaw Point Road and the Birch Lake plantation, contained three plots each, with the treatments consisting of: (1) full release, (2) moderate release, and (3) no release. The third experiment, in Itasca Park, contained only moderate release and no release.

Squaw Point Road White Pine Release Plots

The Squaw Point Road white pine (*Pinus strobus* L.) release plots are in north-central Minnesota (fig. 1). These were established by the Lake States Forest Experiment Station in 1934 to study the release of small white pine poles from aspen and birch, which were severely suppressing the young pine. Three 1-acre plots were laid out in a 36-year-old aspen-birch stand which had a natural white pine understory averaging 28 years of age.

On one plot all of the hardwoods were cut (full release). On the second, only those hardwoods that were overtopping pines were cut (moderate release). On the third, no cutting was done (no release). These plots were remeasured at intervals up through 1956, and during this time no other cutting was done. The white pine, 50 years old in 1956, have suffered no apparent damage from

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either blister rust or the white-pine weevil. The site index for eastern white pine is approximately 65 feet at 50 years.

Although the three plots were similar in most stand characteristics before release at age 28, the one given full release had more white pine trees than did the other two plots (315 per acre compared to 231 and 226 in the moderate-release and no-release plots, respectively). This difference may magnify the contrast between full release and no and moderate release in this study. On the moderate-release plot 70 percent of the basal area was removed in the release treatment, and on the full-release plot 90 percent was removed.

Birch Lake Plantation Red Pine Release Plots

The part of the Birch Lake Plantation in which the red pine (*Pinus resinosa* Ait.) release plots were located was planted in the spring of 1915 with 1-1 stock at a spacing of 8 by 8 feet. By 1931 aspen was competing strongly with red pine over much of the plantation. To test the effects of release on the growth of the 19-year-old red pine, three ¼-acre plots were established by the Lake States Forest Experiment Station in 1931. On one plot all pines were released from competition with aspen (full release). A few small aspen trees were left that did not appear to be in direct competition with pine. On a second plot only the better pines were released, leaving some aspen as part of the stand (moderate release). The other plot was left untreated (no release). The stands were measured periodically for 25 years following release, and no further cutting was done. Earlier results of this study were reported by Young and Eyre (1937) and by Roe (1951). The site index for red pine is about 60 feet at 50 years.

Before treatment the three plots were roughly comparable in stand characteristics (figs. 2 and 3). The release treatments on this study were not so severe as those on the Squaw Point Road experiment. Twenty-eight percent of the basal area in trees 0.6 inches d.b.h. and over was removed by moderate release, and 58 percent was removed by full release.

The contrast between full release and moderate and no release on this study was not as marked as on the Squaw Point Road white pine release tests, probably because of insect damage. In 1934, 1935, and 1936 forest tent caterpillars defoliated

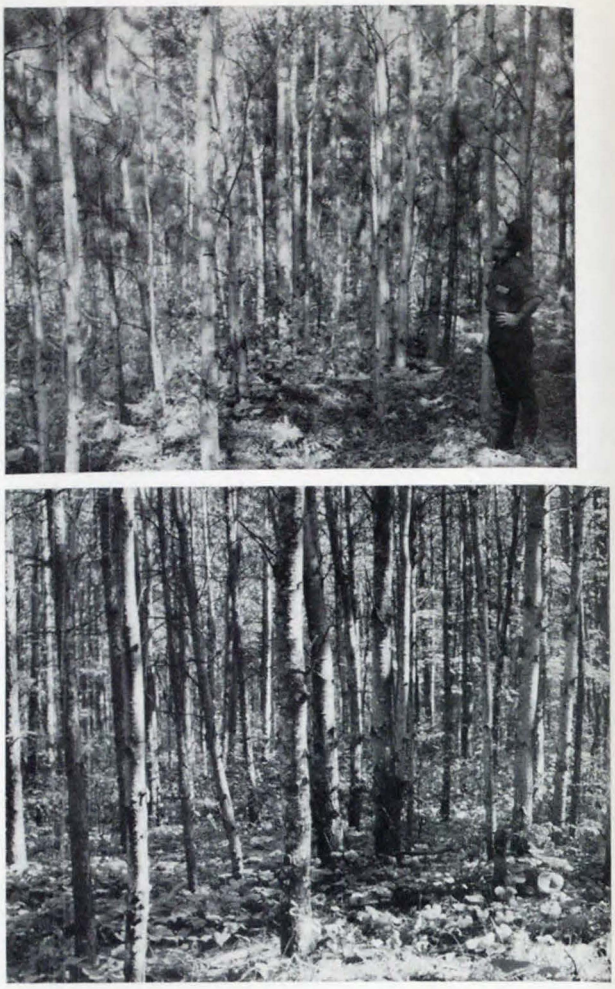

FIGURE 2. — No-release plot in Birch Lake Plantation, Superior National Forest; red pine stand at 24 years of age (*above*), and at 45 years of age (*below.*).

aspen in the study area. These were also drought years. The defoliation and drought resulted in some mortality and a reduction of net growth of the aspen on the moderate- and no-release plots. They thus sustained a natural release treatment, temporary in effect. If this aspen defoliation had not occurred, there would likely have been a greater contrast among the release treatments.

Itasca Park Pine Release Plots[2]

In Itasca State Park during the fall of 1939 ten acres of 35-year-old white and red pine, suppressed by an overstory of older aspen and birch, were released and thinned as part of the Civilian Conser-

[2] *Appreciation is due the Division of Forestry, Minnesota Department of Conservation, for making available data from this experiment.*

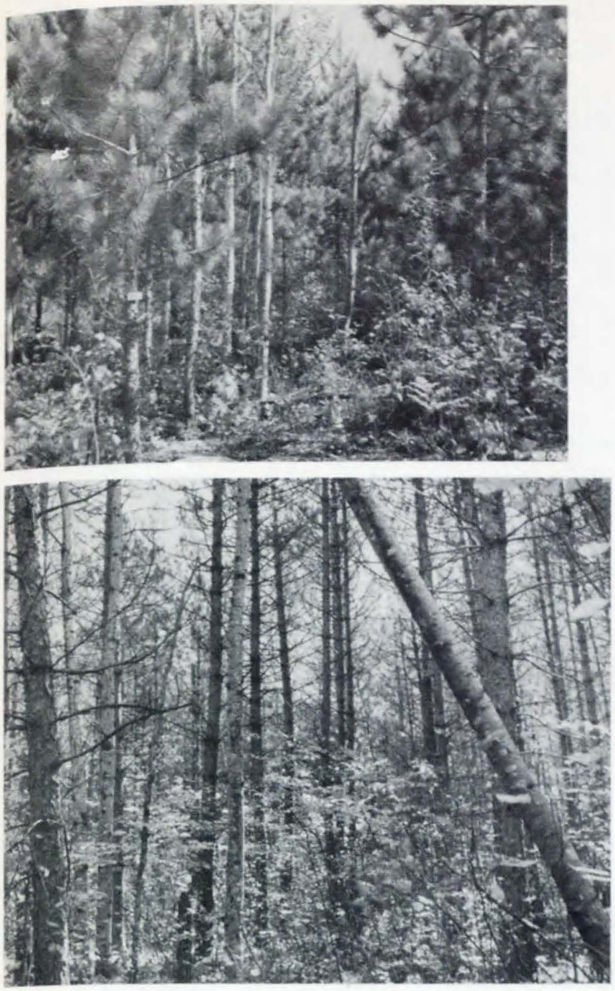

FIGURE 3. — Full-release plot in Birch Lake Plantation, Superior National Forest; red pine stand at 24 years of age (*above*), and at 45 years of age (*below*).

TABLE 1. — *Percent of basal area in conifers 3.6 inches d.b.h. and larger at the time of release and 18 to 25 years later*

Item	Release treatment		
	None	Moderate	Full
Squaw Point white pine			
Immediately after release	3	11	100
22 years later	18	46	92
Birch Lake Plantation red pine			
Immediately after release	29	76	91
25 years later	55	77	96
Itasca Park pine			
Immediately after release	62	86	(1)
18 years later	67	93	

[1] *No full-release treatment was made at Itasca Park.*

TABLE 2. — *Cordword volume per arce in trees 3.6 inches d.b.h. and larger immediately after release and at 18 to 25 years following release on three pine release studies in northern Minnesota*

Item	Cordwood volume on plots with—		
	No release	Moderate release	Full release
	Cords per acre		
SQUAW POINT ROAD WHITE PINE			
After release at age 28:			
Conifers	0.2	0.4	1.0
Hardwoods	10.1	2.0	0
Total	10.3	2.4	1.0
22 years later:			
Conifers	4.5	14.8	33.2
Hardwoods	23.8	16.2	0.9
Total	28.3	31.0	34.1
BIRCH LAKE PLANTATION RED PINE			
After release at age 19:			
Conifers	0.8	0.9	0.6
Hardwoods	1.6	.1	0
Total	2.4	1.0	0.6
25 years later:			
Conifers	17.6	26.3	34.2
Hardwoods	13.1	5.8	1.1
Total	30.7	32.1	35.3
ITASCA PARK PINE			
After release at age 35:			
Conifers	10.8	8.9	
Hardwoods	6.6	1.5	(1)
Total	17.4	10.4	
18 years later:			
Conifers	25.7	31.5	
Hardwoods	12.4	2.3	(1)
Total	38.1	33.8	

[1] *No full-release treatment was made at Itasca Park.*

vation Corps program in Minnesota. To study the effects of the treatment, two ¼-acre plots were established. One was given no release treatment. The other and the entire area outside the study plots were given a moderate release; the aspen and birch that were competing with, over-topping, and injuring the pine were removed. In addition, densely stocked areas of pine were thinned to an average spacing of 6 by 8 feet on the treated area. No cutting was done on the plots from the time they were established up through the last measurement. In 1957 the site index for both white and

red pine was estimated to be 55 feet at 50 years.

Both plots were similar in number of trees, basal area, cubic-foot volume, and cordwood volume before treatment at age 35. However, this mixed pine stand was much denser than that at either the Squaw Point Road or the Birch Lake Plantation experiments both before and after release. It also had a higher proportion of pine to hardwoods in the stand. On the moderate-release plot, 36 percent of the basal area was removed in the combined release-thinning operation.

Silvicultural Results of Release

Eighteen to twenty-five years following release, several important silvicultural differences show up in the various treatments. These differences are most conspicuous in terms of species composition, size of trees, and cordwood and sawtimber growth.

Changes in Species Composition and Size of Trees

The immediate effect of release on the three study areas was to alter stand composition partially or completely in favor of the more valuable pines, depending on the degree of release. The early advantage given the pines has been largely maintained on all three experiments.

For the full-release treatment at Squaw Point, 92 percent of the basal area was in white pine 22 years after release (table 1); the one at Birch Lake had 96 percent of the basal area in red pine 25 years following release. The moderately released plots at all three locations maintained or increased the proportion of pine over the intervening years. In the stands not released the proportion of basal area in pines also increased, but a large amount of less valuable hardwoods still remain.

A striking feature at Squaw Point, and to a lesser degree at Birch Lake, has been the influence of release on the size of trees. At the time of release, white pine trees 0.6 inch d.b.h. and larger at Squaw Point averaged about 2.4 inches. Twenty-two years later the white pine on the no-release, moderate-release, and full-release plots averaged 5.3, 6.9, and 8.6 inches d.b.h. respectively (fig. 4).

The red pine trees of average size in the Birch Lake red pine plantation were 3.2 inches at the time of release. Twenty-five years later the trees averaged 5.9, 7.8, and 8.2 inches for the no-,moderate-, and full-release plots respectively.

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FIGURE 4. — These cross-sections at breast height are from 50-year-old white pine trees that were of average d.b.h. at the time of release from overtopping aspen in 1934 and were also of average d.b.h. 22 years following their respective release treatments. Left to right — no, moderate, and full release. D.b.h. measurements are 5.3, 6.9, and 8.6 inches respectively.

Cordwood Growth

Removal of hardwoods substantially reduced cordwood volumes both at Squaw Point and Itasca Park (table 2). At Birch Lake the same was true even though much of the material was too small for cordwood.

Eighteen to twenty-five years later all release plots except the one at Itasca Park not only recovered the lost volume, but actually had more cordwood than did those not released. The increases were made up largely by the faster-growing pines. Even at Itasca Park the moderate-release plot had faster pine growth than did the no-release plot and will likely have the larger cordwood volume in a few years.

The 22-year net growth of white pine at Squaw Point has been 32.2, 14.4, and 4.3 cords, respectively, for full, moderate, and no release. The 25-year growth of red pine at Birch Lake has been 33.6, 25.4, and 16.8 cords for the same treatments. And at Itasca Park, the moderate-release plot grew 22.6 cords of pine in 18 years, compared to 14.9 cords on the no-release plot.

Sawtimber Growth

No sawtimber was present on any of the three studies at the time of release. Eighteen to 25 years later all of the plots had at least some sawtimber volume (fig. 5).

At Squaw Point 22 years after release there was more sawtimber on the full-release than on the moderate-release plot, and more on the moderate than on the no-release plot. The same was true at Birch Lake 25 years after release. Only at Itasca Park did the moderate-release plot still not have as much sawtimber volume as did the no-release treatment. As was true with cordwood volume, release heavily favored the conifer component of sawtimber volume.

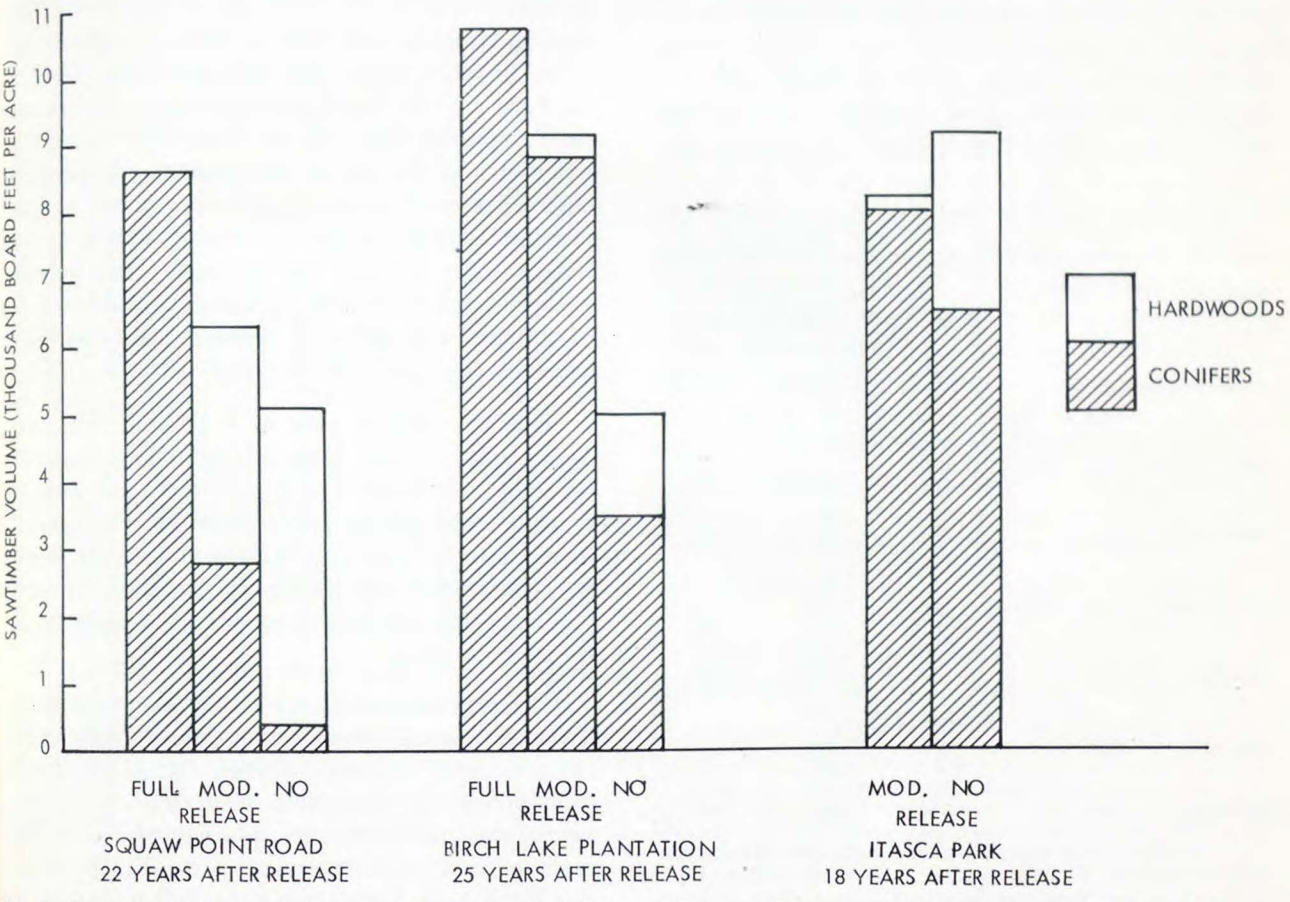

FIGURE 5. — Sawtimber volume per acre in trees 7.6 inches d.b.h. and larger at 18 to 25 years following release on three pine release experiments in northern Minnesota.

Economic Implications of Release

As one would expect, the released plots increased in value at a greater rate than did those given no release (table 3). Furthermore, the greater the release intensity, the greater the rate of value increase.

But a direct comparison of release treatments gives little information as to how much can be spent profitably for release. In fact, such a comparison can be misleading since it ignores the cost of capital invested in release and the different lengths of time in which investments mature on different areas or for different treatments.

However, by using a variation of the soil expectation-value method of economic analysis a comparison of release treatments can be made to determine how much can be invested profitably in release. Returns from the present stands if fully, moderately, or not released were predicted beyond the measurement period from the best volume growth information available. These, together with estimated net returns from future rotations following the present stand, were discounted back to the time of release. The maximum discounted value of the stand if not released was subtracted from the maximum discounted value if released. This difference was the present value of the full- or moderate-release treatment. It was the maximum amount that the forest owner could profitably invest in release at a given interest rate. An explanation of this method and the detailed results of an economic analysis of these three release plots is being prepared and will be reported elsewhere.

TABLE 3. — *Value per acre of timber on three release experiments in northern Minnesota immediately following release and at 18 to 25 years later* [1]

Item	Value where treatment was—		
	No release	Moderate release	Full release
	Dollars per acre		
SQUAW POINT ROAD WHITE PINE			
Immediately after release	12	5	4
22 years later	41	97	222
Increase in value	29	92	218
BIRCH LAKE PLANTATION RED PINE			
Immediately after release	4	3	2
25 years later	118	233	281
Increase in value	114	230	279
ITASCA PARK PINE			
Immediately after release	39	28	
18 years later	200	235	(2)
Increase in value	161	207	

[1] *Assumed stumpage prices: $25 per MBM for pine sawtimber, $3 per cord for pine cordwood, and $1 per cord for hardwood cordwood.*

[2] *No full-release treatment was made at Itasca Park.*

Assume the following: (1) Future stumpage prices will be constant at $25 per MBM for pine sawtimber, $3 per cord for conifer cordwood, and $1 per cord for hardwood cordwood; (2) the forest owner discounts future returns at a compound interest rate; (3) following the first rotation, subsequent stands of pine can be established for $40 per acre; and (4) annual management expenses are $0.30 per acre.

Under these conditions and with a discount rate of 4 percent, the forest owner could invest profitably as much as $144 per acre for full release or $92 for moderate release (a figure which just happens to coincide with the increase in value given in Table 3) on areas with the same conditions as the Squaw Point Road white pine plots. If release costs were less than this he would make more than 4 percent on his release investment. On the Birch Lake Plantation plots, however, release was not so effective from an economic standpoint. Here only $25 per acre for full release or $16 per acre for moderate release could be invested profitably. On the Itasca Park plots, up to $25 per acre could be invested profitably for moderate release.

With a discount rate of 6 percent the forest owner could have invested profitably only the following amounts: $70 for full release and $45 for moderate release per acre on the Squaw Point Road plots; $14 for full release and $8 for moderate release per acre on the Birch Lake Plantation plots; and $20 per acre for moderate release on the Itasca Park plots.

The less the cost of release, the more attractive it becomes as an investment. For example, if full release could be accomplished for $10 per acre, then under the conditions outlined it would be a profitable investment on the Squaw Point Road plots even at a discount rate of 15 percent. On the Birch Lake Plantation plots, full release would be profitable at a 7-percent but not at an 8-percent

discount rate. With improved techniques the cost of release probably could be reduced. Cheaper release would mean higher investment returns.

Of course the difference in stumpage price between pine and hardwoods also affects the investment. Because release favors the growth of pine so much, the higher the price of pine in relation to hardwood stumpage, the more attractive release becomes as an investment.

Thus the cost of release, potential growth, and market expectations all greatly influence decisions about release. Careful estimates of these factors are required before a meaningful economic appraisal of release can be made. The three release study areas evaluated here show a wide variation in investment opportunities. However, they also indicate that under some conditions release is an excellent investment opportunity in forestry.

Improvements in Release Techniques

One is impressed by the opportunities to improve on release techniques and timing as they were used in these three studies. For example, the youngest of the stands at the time of release was the Birch Lake Plantation at age 19. The Squaw Point Road white pine was 28 years (the hardwoods were slightly older at 36 years), and the Itasca Park stand 35 years at the time of release. Although effective at these ages, how much lower the costs of release might have been, or how much more favorable the response had the release been done at an earlier age!

Of course, if done too early there is always the possibility that the stand may have to be released two or more times because of sprouting or suckering of hardwoods. But even in this situation the extra cost is likely to be partially or completely offset by the increased early growth of conifers.

Another improvement in release technique that most certainly would be employed in many situations today is hand or aerial application of silvicides. Present-day costs of aerial application of chemicals amount to $5 or $6 per acre, and sometimes these costs can be reduced. Hand release is often cheaper and less destructive to the residual stand if, instead of felling, the trees are frilled or girdled and poisoned with chemicals. The dead trees then disintegrate slowly. Roe (1955) and Arend and Roe (1961) present a discussion of various aspects of chemical release in the Lake States.

Other Considerations in Release

These three studies indicate that the more complete the release, the more pronounced the growth response of the valuable conifers.[3] Sometimes full release may be obtained at a cost not too much greater than moderate release. For example, at Squaw Point Road 70 percent of the stand basal area was removed to give moderate release, while 90 percent — or 20 percent more — was removed to give full release. In the Birch Lake Plantation about twice as much basal area was removed on the full-release plot as on the moderate-release plot. At Itasca Park 36 percent of the stand basal area was removed to give moderate release; the removal of 9 percent more basal area would have given full release from hardwoods. Of course, if release is done from the air with silvicides, full release can be obtained at practically the same cost as partial release.

When release is done by hand, an indirect benefit frequently occurs as happened in the Itasca Park experiment; this is in spacing and improving the quality of the residual pines. Before release, the pines may be too dense, of mixed species, or of variable quality. In actual practice not only are the hardwoods removed, but the young pines are better spaced, the least valuable pines (usually jack pine) are removed if a choice exists, and the remaining pines are chosen for form and freedom from defect and disease. This operation is not, strictly speaking, release; it includes pre-commercial thinning and sanitation cutting. It nevertheless is an operation frequently done in conjunction with work primarily directed at release.

Summary

Three release experiments were begun in northern Minnesota by the Civilian Conservation Corps program in the 1930's. Two of the experiments

[3] *This point is nicely illustrated in photographs of the full-release plot at the Birch Lake Plantation (fig. 3). Notice the three small aspen in the center of the top photograph. At the time of release these three trees were not considered competition with red pine. Twenty-five years later these same three aspen trees appear to be large enough to be full-fledged competitors of red pine.*

tested the response of pines to full, moderate, and no release from competing hardwoods. The third experiment tested only moderate and no release of pine from hardwoods.

Eighteen to 25 years later the three experiments were given final measurements. The results of the three experiments at the end of the measurement periods have been:

1. The early advantage in species composition given the pines by hardwood removal has been largely maintained. The coniferous component of the no-release plots has also increased, but considerable portions of the plot volumes are still in hardwood.
2. The average size of pine trees was appreciably larger on the released than on the no-release plots at the end of the measurement periods.
3. Although cordwood volumes were reduced considerably by release, the faster growing pines not only recovered the lost volume, but at the end of the measurement period the release plots actually had more volume than did no-release plots. The only exception occurred in the moderate-release plot of the third experiment, and even here 18 years after release the conifers had grown faster on the moderate than on the no-release plot.
4. Conifer sawtimber volumes increased with the intensity of release.
5. The cost of release and market expectations greatly influence decisions about release. Although the three release study areas varied widely in opportunities for profitable investment in release, they indicated that under some conditions release is an excellent investment opportunity in forestry.
6. Release, although effective in these three studies, would probably have been cheaper and more effective if it had been done at earlier stand ages. Release at an earlier age would probably have reduced costs and produced a more favorable response in all three experiments. Silvicides, applied by hand in frills or girdles, or sprayed from the air, would be used in many situations today.
7. The more complete the release, the more favorable the response of the valuable conifers. Sometimes full release can be achieved without too much additional cost. Occasionally other benefits, such as pre-commercial thinning and sanitation cutting, accrue from work primarily directed at release.

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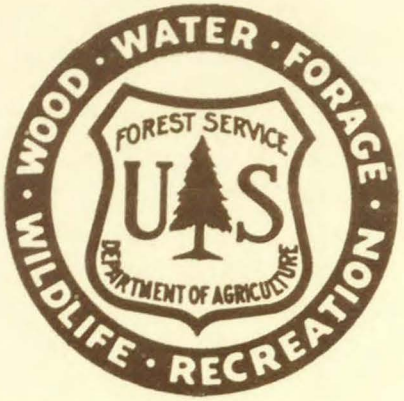

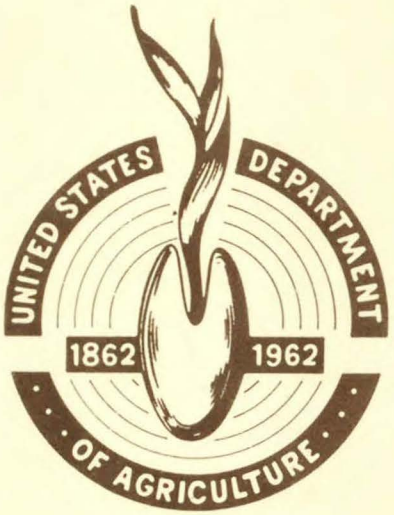

Growth Through Agricultural Progress